INSTITUT NEEL and LNCMI Grenoble

PhD Thesis project

High sensitivity thermodynamic measurements for the study of spin-charge fractionalization in condensed matter physics

General scope. Electrons in solids can generally be viewed as elementary particles carrying a spin (S=1/2) *and* a charge (q=-e). However, in some cases, those elementary degrees of freedom can be "broken" in more fundamental quasi-particles carrying either the spin *or* the charge. *Spin-charge fractionalization* has for instance been introduced to describe the excitations in so-called "quantum spin liquids" which are expected to be neutral particles (q=0) of spin S=1/2, called *spinons*. Similarly, experiments in Kondo insulators recently suggested the existence of electrically neutral Fermi surfaces emerging from the formation of charge less quasi-particles formed by itinerant electrons binding with the charge component (called *holons*) of fractionalized localized electrons. Unravelling the mystery of this fractionalization of the electron into its charge (*holons*) and spin (*spinons*) components is today one of the most intriguing issue of solid-state physics.

Subject. During this PhD internship, we plan to study this fractionalization issue in various systems through thermodynamic measurements. We intend to use two highly sensitive complementary thermodynamic probes : **specific heat** (in the group of Thierry Klein and Christophe Marcenat) and **ultrasound** (in the group of David Leboeuf)] in order to study possible *phase transitions* triggered by the temperature or applied magnetic field and to determine the *low energy excitations* of those compounds.

Environment and collaborations. This internship will be carried out at the Condensed Matter & Low Temperature Physics department of the Neel Institute, CNRS-Grenoble, and at the LNCMI-CNRS, Grenoble (High Magnetic Fields Facility). The thesis will be directed by Thierry Klein and David Leboeuf in close collaboration with Christophe Marcenat. This work will also be performed in collaboration with National (Paris) and International (Sherbrooke, Tokyo, Kosice) partners.

Required skills: The candidate must have validated a master program in condensed matter physics, with a good knowledge of the fundamental concepts in quantum mechanics and solid-state physics. A strong interest for quantum materials and challenging experiments in extreme temperature (down to 100mK) and magnetic field (up to 36T) conditions is required.

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